Evaluation of Nitrogen Fertilization Practices for Surface-Irrigated Lemon Trees – 2012[1]

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Abstract

Lisbon lemons were treated with N levels ranging from 0.5 to 3.0 lbs. N per tree annually. Fourth–season yield results from the trial show significant effects of the treatments upon overall yield and leaf N concentrations, but no effect upon fruit packout. Treatments did lead to a significant effect upon leaf nutrient concentration. Total cumulative yields from 2008 to 2012 (not including the freeze-affected 2011-12 season) were significantly affected by the treatments. Trees treated annually with 2.0 lbs N had the greatest yield, which represented a 12% increase over the yield of trees treated with just 0.5 lbs. N annually.

Introduction

The University of Arizona first published nitrogen and phosphorous fertilization recommendations for lemons on the sandy soils of the Yuma Mesa in 1961[2]. Using ammonium sulfate for that study, Hilgeman and Rodney reported that for lemon trees on the Superstition sand, 2½ lbs. of N per tree was sufficient for phosphate-fertilized trees up to 4 years of age. They also reported that for those young lemons, there was no improvement in yield as N fertilization increased to 4 lbs. per tree. These authors did not report results for older trees, nor did they correlate their results with lemon leaf nitrogen concentration; instead they noted that when leaf N levels dropped below 1.9% for grapefruit and 2.2% for orange, fertilization was required.

Table 1. Recommended N application rates based on leaf N concentration.

Total N in Leaves	Apply this amount of N per tree
%	Lbs.
<2.2	3 - 4
2.2 – 2.3	2 - 3
2.4 – 2.6	1 - 2
2.7 – 2.8	½ - 1
>2.8	0 - ½

Adapted from Doerge et al.

Thirty years later, Doerge *et al*. recommended that N fertilization rates for mature citrus should vary based on leaf concentration as shown in Table 1[3]. For mature citrus orchards, these authors recommend 2 to 3 lbs. N per tree on sandy soils; however they also suggest higher rates for lemons. It is unclear whether those higher rates refer to 3 lbs. per tree or more.

[1] The author wishes to thank Mr. Arturo Moreno and Associated Citrus for their assistance in completing this project. The author would also like to thank the Arizona Citrus Research Council for supporting this research. This is a final report for project 2011-01 – Evaluation of Nitrogen Fertilization Practices for Surface-Irrigated Lemon Trees – 2011. Because of the freeze of January 2-4 2011, the trees did not fruit in the 2011-12 season, and the author was granted a no-cost extension through the 2012-2013 season.

[2] Hilgeman, R.H and D.R. Rodney. 1961. Commercial citrus production in Arizona. University of Arizona Agricultural Experiment Station and Cooperative Extension Service Special Report No. 7. University of Arizona, Tucson, AZ.

[3] Doerge, T.A., R.L. Roth and B.R. Gardner. 1991. Nitrogen fertilizer management in Arizona. University of Arizona College of Agriculture Publication No. 191025.

The most recent work that addressed the lemon fertilization question was done by Sanchez *et al.*, in 2002[4]. In that one-year study, on 8-year old lemon trees, just three rates (0, 1.5 and 3.0 lbs.) of N per tree were applied via surface irrigation, along with foliar N fertilization and P application. These authors noted that just 1.5 lb. N per tree was sufficient for maximum yield. It should be noted that this study was not conducted on Superstition sand, but rather on Superstition complex soil, a soil in which the sand is topped with a silt layer. Their results are similar to Hilgeman and Rodney's 1961 the recommendation of 1 to 2 lbs. N for lemons planted in Superstition complex. From this survey of the literature, it becomes apparent that there are still no concrete N fertilization recommendations for mature lemons grown in the Superstition sand. Therefore, our objective is to establish and conduct an N fertility trial to establish those recommendations.

Materials and Methods

This experiment was established in 2008 in a commercial lemon block near County 14th Street and Avenue 3E. There are six treatments, 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 lbs. (Treatments 1-6) nitrogen per tree. A treatment unit consists of four adjacent trees in a row, and experimental design was randomized complete block, with seven blocks. Therefore, there are a total of 42 treatment units, (168 trees, 1.54 acres) included in the experiment. Spacing is 20 ft. by 20 ft. Each treatment consists of 7 treatment units, one for each block, with a total of 28 trees, or 0.26 acres. Guard rows separate one treatment from the next where possible. Irrigation is border flood, and normal cultural practices are used.

Data was taken for the 2008-09, 2009-10 and 2010-11 seasons. The entire yield was lost for the 2011-12 season due to freezing temperatures on January 2 to 4, 2011, when daily minimums ranged from 20 to 25F. Damage was exacerbated in the experimental block because the grower topped and hedged the trees just prior to the freezing temperatures causing additional damage.

For 2012-13, nitrogen was applied as UN-32 (32-0-0) or 15-0-0-16S. Most treatments were applied at a rate of 4.0 or 7.5 gallons per acre. For treatments 5 and 6 (2.5 and 3.0 lbs. N per acre), a double application was applied as needed. Application details are found in Table 2.

Table 2. Details of N application rates, materials, and timings.

Date	Material	Rate (gpa)	Treatments	Rate (gpa)	Treatments
15-Jan-12	32-0-0	10.0	1,2,3,4,5,6		None
12-Mar-12	32-0-0	4.0	1,2,3,4,5,6		None
3-Apr-12	32-0-0	7.5	3,4,5,6		None
19-Apr-12	32-0-0	4.0	4,5,6		None
4-May-12	15-0-0-16S	4.0	1,2,3,4,5,6		None
21-May-12	32-0-0	7.5	3,4,5	15.0	6
1-Jun-12	32-0-0	7.5	2,3,4	15.0	5,6
15-Jun-12	32-0-0	7.5	4,5	15.0	6
29-Jun-12	32-0-0	7.5	2,3,4	15.0	5,6
13-Jul-12	32-0-0	4.0	5,6		

Liquid fertilizer was applied to the soil surface using a boom sprayer, one to two days prior to a flood irrigation event. Leaf samples were collected for N analysis in August, 2012.

The sole harvest for the 2012-13 season was 10-25-12. Yield was lighter than normal for the season due to the lingering effect of the freeze of January 2011 and the topping and hedging. For the harvest, workers picked all marketable fruit. For each harvest, fruit from each tree was harvested by hand into sacks using professional pickers from a local packinghouse. Yields were calculated by counting the number of sacks harvested from each tree. Fruit from the sacks was poured into plastic bins, each holding approximately 800 lbs. About 40 lbs. of fruit were removed from the sacks into plastic sample tubs for determination of packout. Fruit from the tubs was optically sorted using a

[4] Sanchez, C.A., G.C. Wright and M. Peralta. 2002. Continued evaluation of N fertilization practices for surface-irrigated lemons. In: G.C. Wright and R. Gibson (eds.). 2003 Citrus and deciduous fruit and nut research report. University of Arizona Cooperative Extension Publication No. AZ 1331.

completely automated photographic sorter (Autoline, Inc., Reedley, CA). This sorter is trailer-mounted so that it can be towed to the citrus orchard study site. Each fruit that passes through the sorter was photographed and weighed. Weight, color, exterior quality (% blemish), fruit shape and fruit diameter data was collected for each fruit. Fruit were not physically sorted, but the data collected was stored in a laptop computer that is an integral part of the sorter. Data collected from the sorter were later analyzed and the percentage of fruit from the eight fruit sizes and fruit grades (fancy, choice and juice) as well as fruit peel color and shape were determined. Our results typically show that fruit is larger than is the case if the packout was determined at the packinghouse. This due to the fact that we measure each fruit shortly after it is removed from the trees. In typical packinghouse reports, the percentage of large fruit is less, because fruit shrinks as it moves through the house, and the reports are taken after the fruit is degreened, washed, waxed and dried. Throughout this experiment, we found no effect of the treatments on fruit grade, shape or peel color, In general, exterior fruit quality ranged from 82 to 89% fancy, about 7 to 11% choice, and 4 to 7% juice.

All data was analyzed using IBM SPSS 19.0 for Windows (SPSS Inc., Chicago, Illinois).

Results and Discussion

Yields for the 2012-13 season appear in Figure 1. For the 10/25 harvest, yields ranged from 185 lbs. per tree for the trees treated with 3.0 lbs. per tree to 217 lbs. per tree for the trees treated with 2.0 lbs. per tree. Despite the range of yields, we found no significant effect of the treatments upon yield. This is likely due to the variability among trees; a variability that was probably increased due to the effects of the freeze. Similarly, there were no apparent effects of the treatments upon packout (Figure 2). Percentage of fruit sized 75 ranged from 5.1% for the trees treated with 0.5 lb. N to 7.7% for the trees treated with 1.0 lb. N. For fruit sized 95, the treatments led to packouts of 31 to 39%, and for fruit sized 115, packouts ranged from 22 to 24%.

Our yield results were reflected in the leaf N concentration levels of the treated trees (Table 3) as there was a significant effect of treatment upon leaf N concentration. Leaves of trees given 0.5 lb. N had significantly lower leaf N concentration (1.93%), while leaves of trees given between 1.0 lb. and 3.0 lb. N had 2.14 to 2.35% N.

Annual leaf N concentrations from 2008 through 2012 (not including 2011) are shown in Figure 3. Trees provided just 0.5 lbs. of N annually consistently had the lowest leaf N concentrations, and in 2009-10 and 2012-13, those concentrations were less than 2.0%. Leaf concentration for the lowest N application rate was significantly less than the concentrations for all the other rates in the 2012-13 season. All the others had concentrations above 2.0% N. It is worth noting that most years; all leaf N concentrations were deficient or low, according to recommendations from Florida[5]. This is likely because of the fact that N fertilizer uptake, for trees in the sandy Yuma Mesa soil, is inefficient since the soil is quite permeable. N fertilizers are easily leached past the tree root zone as they are carried in the flood irrigation waters. It is possible that even at the highest N application rates, leaf N concentrations may not surpass 2.4%

Cumulative yield for the entire experimental duration is shown in Figure 4. For the four year duration, trees that were given just 0.5 lb. N had significantly less yield (1471 lbs.) than those trees given 2.0 lbs. of N (1654 lbs.). This represents a 12% increase in yield. All other application rates had intermediate levels. One might expect this trend to continue if the experiment were continued for additional years.

[5] Koo. Et al., 1984. Recommended fertilizers and nutritional sprays for citrus. Florida Cooperative Extension Service Bulletin 536D.

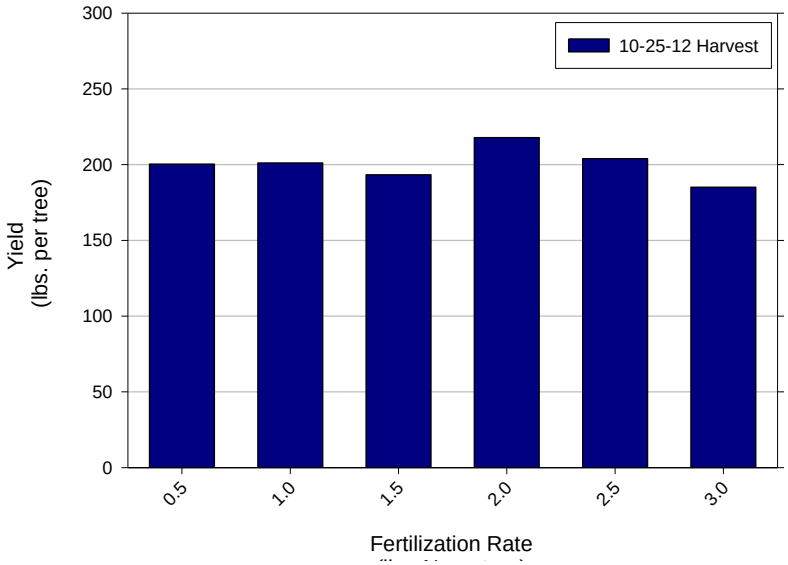

Figure 1. 2012-2013 season yields for lemons treated with various N levels.

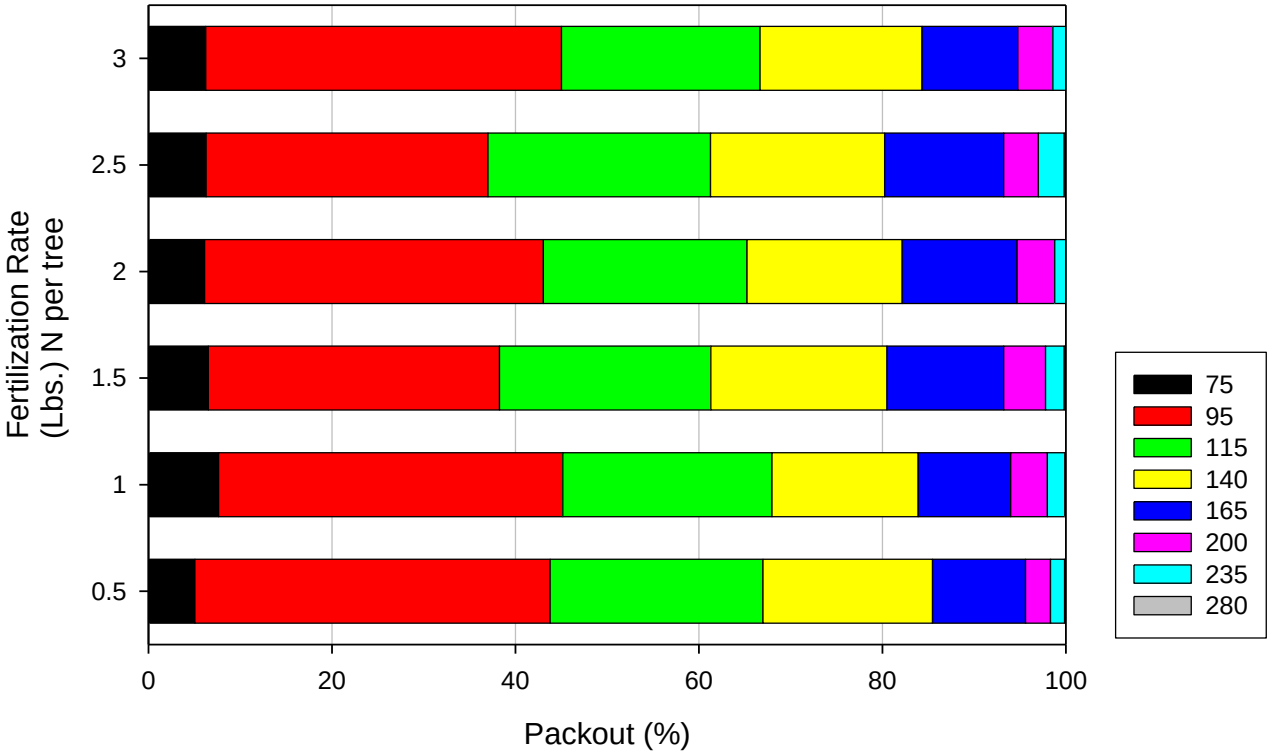

Figure 2. 10-25-12 packout of lemons treated with N levels ranging from 0.5 to 3.0 lbs. of N per tree.

Table 3. August 2012 leaf N concentrations of lemons treated with N levels ranging from 0.5 to 3.0 lbs. of N per tree.

N applied (lbs.)	Leaf N Concentration (%)
0.5	1.93 a
1.0	2.14 b
1.5	2.19 b
2.0	2.29 b
2.5	2.30 b
3.0	2.35 b

[z] Means separation in columns by Duncan's Multiple Range Test, 5% level.

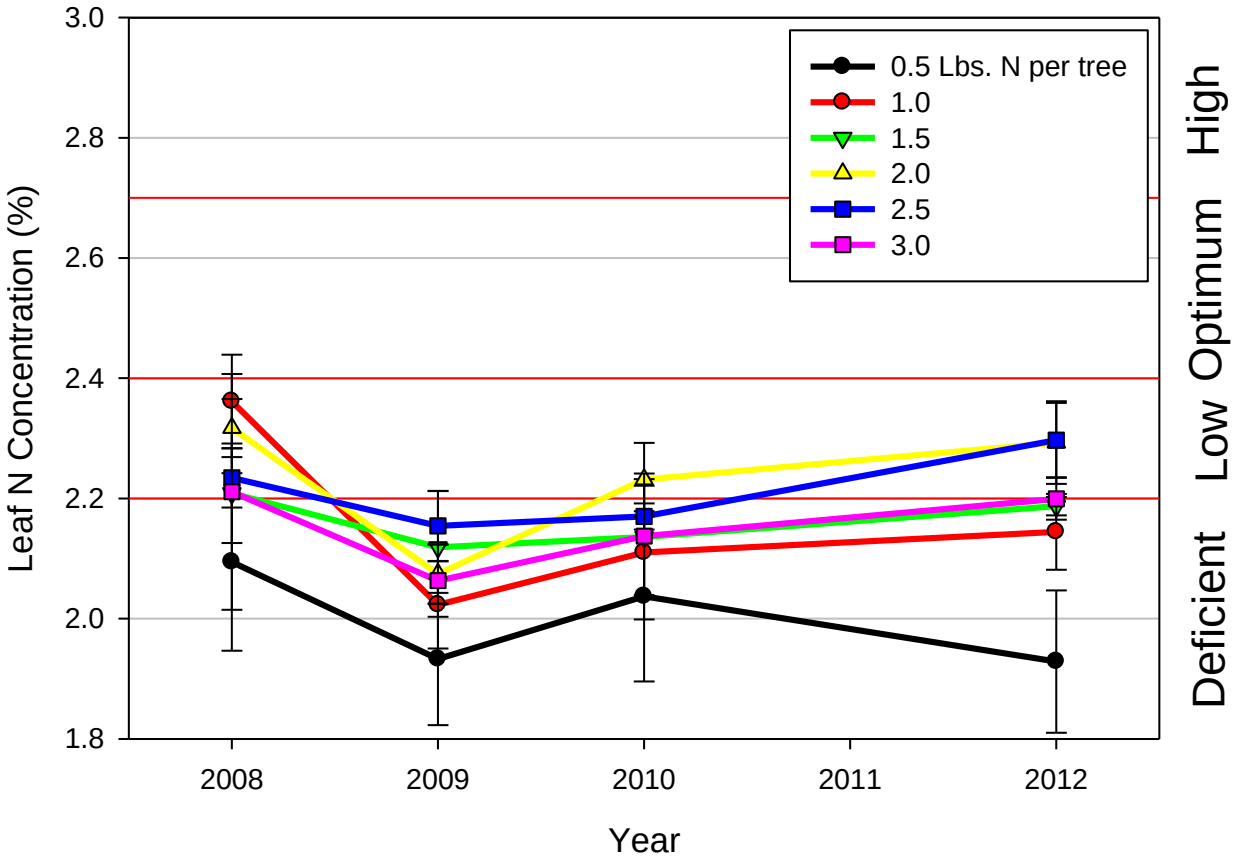

Figure 3. Annual Leaf N concentration of lemons treated with N levels ranging from 0.5 to 3.0 lbs. per tree.

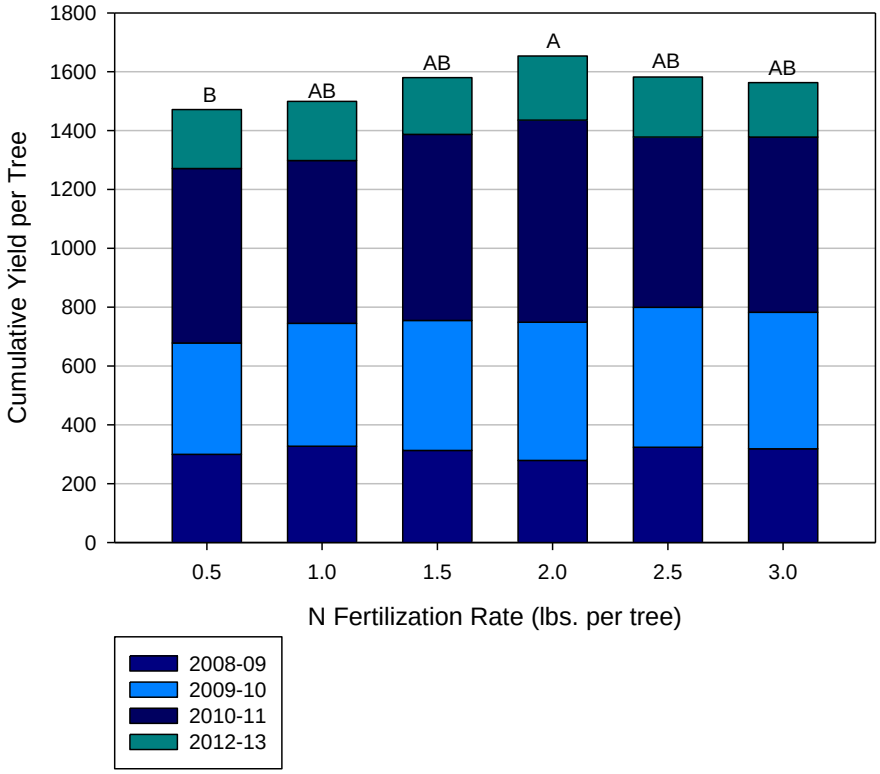

Figure 4. 2008-2012 Cumulative yields for lemon trees fertilized with annual N levels between 0.5 and 3.0 lbs. N per tree.